The Sheep Creek Resource Conservation Area Project

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ABSTRACT

The Sheep Creek Resource Conservation Area project was implemented from 1957 to 1966 to stabilize and rehabilitate the upper watershed of Sheep Creek, a tributary to the Paria River in southern Utah. The project was a cooperative effort involving six Federal agencies, the Utah Division of Wildlife Resources, and private landowners. Rehabilitation and stabilization measures included construction of detention dams, dike water-spreader systems, gully plugs, and check dams. In addition, numerous seeding and brush control projects were undertaken, and livestock grazing was more intensively managed. The Sheep Creek Barrier Dam has been particularly successful in trapping coarse sediments, which resulted in the establishment of a 15-ac riparian resource, and has contributed to the stabilization and restoration of over a mile of deeply incised gully. Land treatments have been successful when accompanied by subsequent compatible land use management, but were less effective in areas with poor resource potential or incompatible land use management. Overall, the Sheep Creek Resource Conservation Area project has resulted in reductions in downstream sediment delivery and an enhanced onsite vegetation resource for wildlife, livestock, and watershed-related values.

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The Sheep Creek Resource Conservation Area
A Project Summary and Evaluation

Introduction

The Sheep Creek Resource Conservation Area (Figure 1) was created as a result of field investigations during the 1950s by the Bureau of Reclamation. The Bureau was considering constructing a dam on the Colorado River in Marble Canyon near Lee's Ferry, Arizona. They were concerned that the small reservior created by the dam would fill rapidly with sediment. The Paria River drainage produced the highest sediment concentrations of any subwatershed within the Colorado River system and would be a major source of sediment to the Marble Canyon Project. Sedimentwater ratios (Qs/Qw) for the Paria River average 0.164. Available data for other southwestern streams indicate this ratio to be about 15 times that for the Virgin and San Rafael Rivers, 9 times that of the San Juan River, and 3 times that of the Little Colorado River.[1] Thus, it was believed that watershed stabilization actions in the Paria River Basin would serve to extend the life of the proposed dam. Several small drainages within the Paria River basin were examined before Sheep Creek (Figure 2) was selected in 1956 as the site for an interagency watershed stabilization demonstration project.[2] Sheep Creek was selected because it was an area in poor watershed condition with good treatment potential. An interagency group was formed in 1956 to undertake drainage-wide actions to reduce soil loss. The participating agencies were: USDI Bureau of Land Management, USDA Forest Service, USDI National Park Service, USDI Geological Survey, USDA Soil Conservation Service, USDI Bureau of Reclamation and Utah State Department of Fish and Game (now the Division of Wildlife Resources).

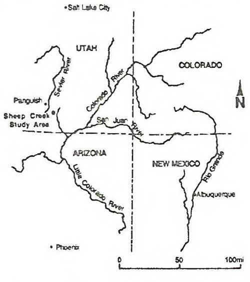

Figure 1. Location of the Sheep Creek Resourse Conservation Area.

The original cooperative agreement was for a 5-year period. In 1962, it was extended for an additional 5 years. Under this agreement, each agency was responsible for conservation development work and management on their respective lands. In addition, the Bureau of Reclamation agreed to construct a large detention dam on the main stem of Sheep Creek at the lower end of the project area.

The purpose of this paper is to describe the Sheep Creek Resource Conservation project, and assess the effectiveness of several stabilization and rehabilitation techniques.

Planning Criteria

To assure that a coordinated stabilization approach was taken, a watershed committee was formed in May, 1956. The watershed committee coordinated planning and provided general project supervision. Planning criteria were developed and included:

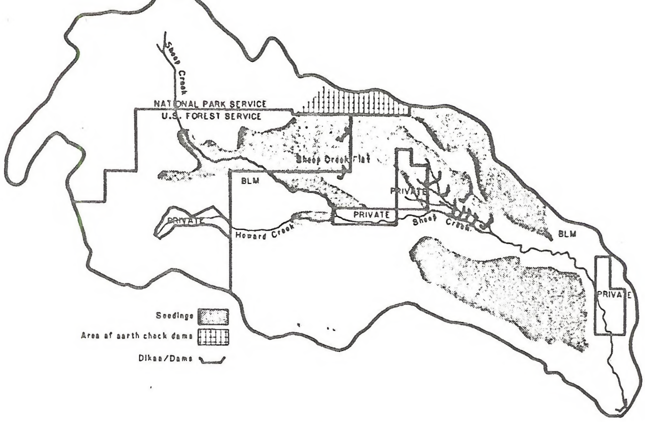

Figure 2. Sheep Creek Watershed above Barrier Dam

1. The Sheep Creek Cooperative Field Demonstration Area should not be strictly a research undertaking, but should be a pilot project in which Government agencies and local watershed users would cooperate in a practical application of land improvement and structural measures to improve watershed conditions, increase the yield of forage and forest products, and decrease sediment yield.

2. Each agency would determine the treatment methods and administrative policies for those lands under its jurisdiction or for which it had planning responsibilities.

3. The work plan prepared by each agency would be coordinated with work plans developed for other areas within the subwatersheds.

4. Each agency would use funds available to it for all of its activities in connection with the project.

5. Each agency would evaluate its own program and would also participate in a joint overall project evaluation.

6. The planning, operations, evaluation, and other activities in connection with the Sheep Creek Cooperative Field Demonstration Project would be carried on under a field agreement between the participating agencies.

Physical Setting

Climate and Vegetation

The upper Sheep Creek area has a mild climate. The frost-free period is about 110 days. Average annual precipitation is approximately 15 inches. The driest months are May and June. The months of highest precipitation are July, August, and September when precipitation is from short duration, high intensity convectional storms. Winter moisture is usually in the form of snow.

The major native vegetation species in the project area are pinyon-juniper, big sagebrush, mountain mahogany, rabbit brush, Gambel oak, lead bush, serviceberry, broom snakeweed, and some grasses such as Indian ricegrass, blue gramma, galleta, Nevada blue grass, some western wheat, and small amounts of sand drop seed. In addition large areas have been seeded to crested and western wheat grass.

Geology - Soils

Geologic formations underlying the Sheep Creek watershed include the Wasatch formation of Tertiary age (Bryce Canyon cliffs), Cretaceous sandstone and shales, and Jurassic sandstone. Each of these, with the exception of the Cretaceous Straight Cliffs sandstone breaks down into a soil subject to rapid erosion.

The central portion of the area is generally flat and is cut by gullies of varying depths and widths. The remainder is characterized by steep hills, some cliffs, and bench tops. The bench tops are generally flat with some rolling hills and small to medium gullies. The elevation varies from about 7,400 ft to 8,400 ft.

Soils in the Sheep Creek Watershed are derived principally from sandstones and shale.

On many of the steep sidehills there is little or no soil development. These sidehills would fall into three major groups: those having some very shallow, moderately fine to fine textured soil underlain by shale with some bare shale outcrops; those having very shallow, moderately coarse to medium textured soils underlain with sandstone with some sandstone outcrops and ledges; and the better sidehills having moderately deep (20-36 inches), moderately coarse to medium textured soils underlain with sandstone with some sandstone outcrops and ledges.

The benches have two major kinds of soils: those with deep (60 inches plus) medium to moderately fine textured soils and those that are generally outwash materials. These gravelly soils are well-graded with some fine soils as well as sands. The gravelly soil extends to a depth of several feet. The benches with the deep soils are well suited for producing grasses.

The valleys or flats are all alluvium. They also are of two major groups: those that are derived principally from sandstone or mixed sediments and those derived from shale. The soils derived from sandstone and mixed sediments are deep (60 inches plus) and are mainly medium textured; however, there are some stratifications of sandy or gravelly materials. The medium textured group of soils is mainly either a very fine sandy loam or a silt loam on the surface. They are structureless and the silt loams crust badly. Infiltration rates are slow on the silt loams and moderate on the very fine sandy loams. These soils are well suited for grass seeding.

The alluvial soils derived from shale are deep and fine textured. These clay soils are very hard when dry and very sticky when wet. The main body of this soil is found on Sheep Flat.

It is very badly eroded with many deep gullies, some of which are 12 ft or more deep. This soil has a very slow infiltration rate and is unstable. On the lower end of Sheep Flat there is a foot or more of silt loam soil that has been deposited over the clay. This area will be the most difficult to reseed or to treat erosion.

Hydrology

The Paria River drains 1,570 square miles of predominantly steep, rugged, and highly erodible terrain. Based upon stream measurements since 1924, the mean annual discharge of the stream at its mouth is 23,000 ac-ft, or 14.63 ac-ft per square mile. Fiftyeight percent of the total discharge occurs during the summer storm period May 15 to October 31. Long-term annual sediment yield is estimated to be 3,700 ac-ft, or 2.4 ac-ft per square mile. More than 95 percent of the total sediment yield reaches the mouth of the stream during the summer storm period.

The Paria River was believed to have such a high sediment yield because an unusually high proportion of the basin area is composed of steep, barren, and highly erodible shales, sandstone, and mudstones; and a continuous gully system exists from the mouth to the headwaters of every major tributary.

The Sheep Creek Resource Conservation Area is 37 square miles with the Barrier Dam being the lowest point in the project area. This basin encompasses approximately 3 percent of the Paria River Basin. The Barrier Dam's spillway was designed to pass a 100-year flood peak of 6,800 cubic ft per second (cfs). Records collected at the Barrier Dam spillway between May 19, 1960, and November 12, 1964, recorded a peak discharge for the watershed of 4620 cfs during the year of November 1962 to November 1963. The maximum annual runoff from these records was 1,108 ac-ft recorded during the same period. The streamgage at the Barrier Dam spillway was discontinued in November 1964, and no continuous streamflow data have been collected since then.

Project Description

A comprehensive resource rehabilitation approach was taken within the Resource Conservation Area to lessen the high sediment production from the watershed. Grazing numbers were adjusted to carrying capacity, season of use was changed, areas dominated by brush and pinyon-juniper were converted to grass, and structural treatments were conducted on the gully system. Treatments were conducted to both heal gully sections and in other areas to remove the water from the gully and spread it over seeded areas

From 1957 to 1962 all participants in the Resource Conservation Area implemented actions on areas under their jurisdiction. In May 1963 the participants submitted a report showing what actions had been accomplished and their costs.

The overall concept in designing structures and land treatments was to provide a balanced mixture of runoff and sediment yield control, erosion stability, and both riparian and upland vegetation restoration. Structures and treatments were designed to be compatible with site conditions and landscape position.

Vegetation treatments included sagebrush plowing, pinyon-juniper chaining, grass reseeding, ponderosa pine seeding, and browse planting. Vegetation treatments were located to be compatible with natural site potential.

Structural treatments included gully plugs, earth check dams, detention dams, water spreaders, and a large

mainstem barrier dam. The barrier dam was located at the downstream end of the project to control channel base levels. Check dams were used in upper headwater reaches at the base of badland formations to detain water, to improve conditions for vegetation growth, and to stabilize downstream gullies. Detention dams were located to control runoff and to induce sediment deposition. Water spreaders were constructed on Sheep Creek Flat, where topography was suitable, to reduce peak flows and to improve soil water conditions for plant growth. The larger structures were designed to effectively handle the 50-year flow, except the barrier dam that was designed to pass the 100-year flood.

Livestock management included fence construction, changed season of use (generally less spring grazing), reduced stocking rates, and development of livestock water.

Evaluation

Some earlier documentation of the Sheep Creek projects is available.[3] In addition, Lusby and Hadley[4] reported on the hydrology, sedimentation, and channel aggradation associated with the Sheep Creek Barrier Dam. To the best of our knowledge, no one has done a written evaluation of the demonstration area since all projects were completed.

Sheep Creek Barrier Dam

Completed in May 1960, this dam created a storage pond with an initial capacity of 87.9 ac. ft. below the spillway sill elevation of 5,868 ft. By September 1961, 107.6 ac-ft of sediment had been trapped above the dam. Another 57.7 ac-ft were deposited by November 1964. In 1964 channel aggradation had extended some 2300 ft upstream of the dam and 21.5 ft above the spillway elevation[4] (Figure 3).

Cumulative sediment deposition is shown as a function of time in Figure 4. Aside from annual variations in sediment accumulation, the rate of aggradation appears to be fairly constant with time. Annual deposition for the period 1960-84 averaged 14.8 ac-ft. By 1961 the reservoir below the spillway elevation had nearly completely filled with sediment. Figure 5 shows the percent deposition above the spillway as a function of time. We believe the deposition above the spillway will eventually exceed that stored in the reservoir. For this to happen, deposition must continue to occur in the channel above the reservoir. In April 1984, the upper limit of deposition was 4670 ft (longitudinal channel distance) from and 59.2 ft (vertical) above the spillway. This sediment wedge will continue to build and steepen until an equilibrium slope is reached or until the upstream sediment supply runs out.

The rate of steepening of the channel is a function of sediment supply, especially those particle sizes that are required to maintain the new channel slope. Figure 6 shows the ratio of the deposition slope to the original channel slope increasing with time. A value of 0.83 was determined from the 1984 survey. This value is in agreement with others measured on coarse alluvial deposits. Steeper deposition slopes, and thus smaller ratios, are usually found in channels carrying coarse sediment. Channels with finer sediment loads are associated with flatter deposition slopes and greater ratios[5].

There appears to be very little free-water storage capacity left above the dam. However, vegetation has invaded the sediment deposit and acts to detain water as well as filter out sediment. A small channel, with an average bankfull capacity of 93 cfs, is incised in the sediment wedge between

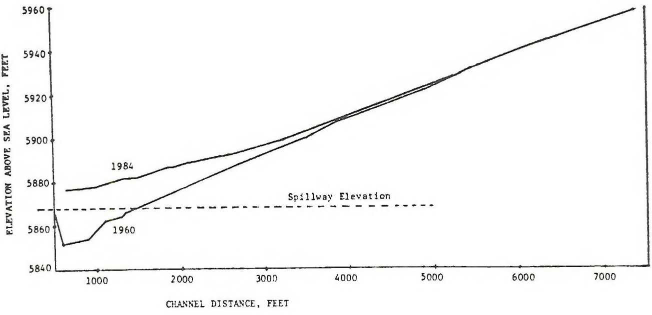

Figure 3. Profile of sediment wedge and channel above Sheep Creek Barrier Dam.

the spillway and the natural channel above the reservoir. A perennial flow at the dam has resulted from water slowly draining from the reservoir sediments. Approximately 15 acres of riparian habitat have developed on the reservoir sediments (Figure 7).

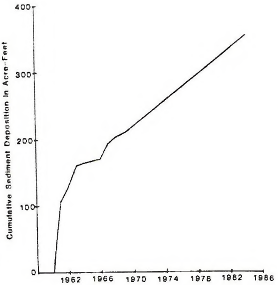

Figure 4. Cumulative sediment deposition behind Sheep Creek Barrier Dam, 1960-1984.

Although little or no reservoir capacity remains, the sediment wedge with its vegetation cover still functions to deposit sediments. Larger sediment sizes may continue to be deposited at the upstream end of the sediment wedge. Fine sediments also deposit behind the dam when flows exceed the capacity of the small incised channel and spread over the reservoir deposit. However, any ongoing sediment deposition represents an insignificant proportion of the total sediment load delivered to the structure from upstream.

In addition to its effects on sedimentation, the Sheep Creek barrier structure most probably still functions to reduce peak flows and downstream flooding. While direct discharge measurements above and below

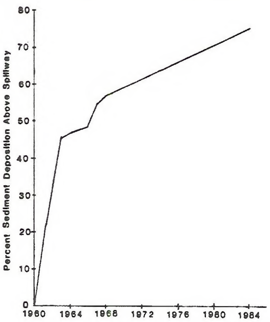

Figure 5. Sediment depsition above Sheep Creek Barrier Dam spillway as a percent of total deposition behind dam.

the structure are unavailable, the channel within the deposit has an average bankfull capacity of roughly 93 cfs (S = 47 cfs). This is a very low capacity in relation to commonly experienced peak flows (the average annual peak discharge from 1960-1964 was 2340 cfs). Thus, flooding occurs on the sediment wedge for all significant runoff events. Flooding serves to reduce runoff peaks compared to a gullied condition, where large flows are totally confined to the channel. In addition, flooding reduces stream energy, allowing sedi-ments to deposit in the channel and on the floodplain. Finally, we be- lieve that flooding is an important aquifer-recharging process.

It is worth mentioning that the Sheep Creek interagency group decided to construct the barrier dam before initiating the large program of headwater treatments. This approach agrees with Heede's[6] recommendation that channel base level should be controlled at a downstream point before on-site runoff and erosion control are implemented in headwater areas.

BLM Detention Dams

Two large earthen detention dams were constructed by BLM, one at the upper end and the second at the lower end of Sheep Creek Flat. Both these structures appear to have been designed and constructed correctly. Storage capacity is large in relation to contributing drainage area. Both structures were designed to pass outflow through culvert dropinlet spillways. Emergency spillways were constructed using the native soil material; neither of the emergency spillways appear to have ever carried water.

The lower detention dam is still functioning adequately and has considerable storage left above the sediment deposit. The sediment wedge extends several hundred feet above

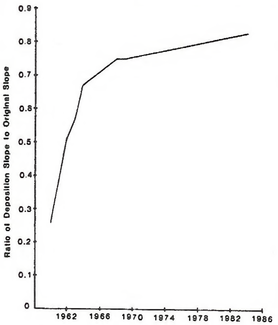

Figure 6. Ratio of deposition slope to original slope, Sheep Creek Barrier Dam sediment deposit.

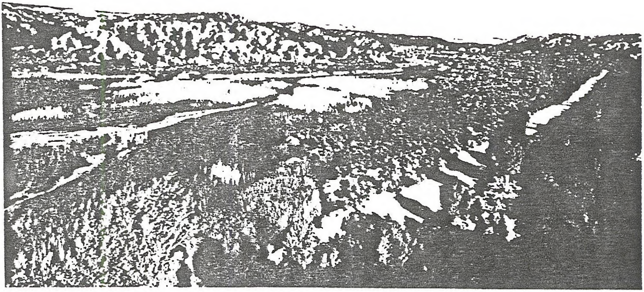

Figure 7. Sediment deposit and riparian habitat above Sheep Creek Barrier Dam.

the dam. The principal spillway is in good condition.

The upper detention dam has filled with sediment to the top of the principal spillway. The spillway is plugged and currently inoperable.

Both structures have met their original objectives of water and sediment control. The upper structure has reached (perhaps prematurely) the end of its effective life due to sediment deposition. The principal spillway will have to be either extended or replaced. If the structure fills and passes large flows through the earthen emergency spillway, there is danger of structure failure. The earthen emergency spillway will likely not withstand large flows without considerable erosion.

Diversion Dikes and Spreader Systems

These systems were installed by BLM for the stated purpose of controlling water, inducing silt deposition, increasing soil moisture, and increasing vegetative production. The systems are functioning to trap water and sediment.

However, in some instances the weep pipes, installed in the dikes to release water to the spreader area, were installed unusually high. This resulted in much ponding of water behind the dike and less water being released below the dike. In the case of one structure at the upper end of Sheep Creek Flat, the spreader system appeared to have a dual purpose of providing stock water and serving as a water-spreader. In other cases, ditches had been constructed below

the weep pipes, concentrating the water and actually preventing "water-spreading." The irrigation benefits of the water-spreader systems could have been improved by using a better design. Finally, improved forage production on the spreader areas has been inhibited by overutilization of the vegetation by livestock.

While the spreaders did not result in significantly improved range condition, they did provide water and sediment control and contributed to reducing flood peaks and stabilizing gullies.

Chainings, Plowing, and Seeding

Chaining, plowing, and seeding projects on both BLM and National Forest lands appear to have been successful from both a watershed cover and livestock forage standpoint. No data are available to support these visual observations.

Gully Plugs and Reseedings--National Park Land

The gully plugs constructed on National Park lands in the headwater areas were extremely successful. Keys to this success included (1) proper design and spacing, (2) placement of uppermost plugs at the toe of the steeper slopes below the watershed divide, (3) repeat attempts at reseeding western wheatgrass until the grass was definitely established, and (4) proper postrehabilitation management. These plugs represent an excellent model for gully plugging in this type of geology, soils, and climate. The plugs will continue to function in spite of "melting down" and silting in due to the successful establishment and management of a vegetation cover. Gully systems below the plugs are stable and vegetated (Figure 8).

A few of the plugs at the upper end of the project area had failed due to their capacity being exceeded. These plugs, being "first in line," should be designed to retain all runoff and sediment from upslope. Thus, in most cases they will be larger than lower plugs. Where topography permits, a more effective practice may be to construct a contour trench (with cross dams) at the base of the steep slopes to increase retention capacity.

Maintenance Aspects

Maintenance on the Sheep Creek watershed projects appears to have been very timely and effective, contributing to the success of many of the projects. The minimum amount of maintenance required to date attests to the proper design and construction procedures used. However, in recent years sediment accumulation behind the Sheep Creek Barrier Dam has resulted in a situation where extremely high flows could result in the breaching of the earthen embankment. Some maintenance, in the form of embankment enhancement may be required to maintain the onsite and downstream benefits associated with that structure.

In addition to proper design, proper land use management is required to minimize maintenance costs. For example, vegetation reestablishment on the National Park Service gully plugs has enhanced their effective life, whereas overutilization of forage on Sheep Creek Flats may have resulted in increased maintenance needs on the water spreaders.

Grazing Management

Grazing management can still be improved in the watershed. Overutilization (90% +) of forage was observed in the Sheep Creek Flat area. Continued heavy use of the spreader projects may result in a severe decrease of preferred grass species and increase in undesirable vegetation. Some modification of the season of

Figure 8. Healed gully above Sheep Creek Flat.

use is also recommended. Spring grazing is probably having undesirable effects on soil and vegetation. To the extent that overgrazing reduces cover and increases runoff and erosion, it also serves to decrease the effective life of downstream erosion and water control structures, such as detention dams and waterspreaders.

Conclusions

Project Benefits

Benefits realized from the Sheep Creek watershed projects include:

- an estimated 1,000 ac-ft of sediment trapped behind erosion and water control structures.
- an estimated 5,000 lineal ft of main channel aggradation
- an estimated 15 acres of riparian vegetation establishment behind the Sheep Creek Barrier Dam, resulting in an increase in both cover and diversity for wildlife habitat
- an estimated 6 miles of gullies healed
- improved watershed cover on an estimated 500 acres
- reduction of flood peaks
- establishment of perennial flow at the Sheep Creek Barrier Dam
- improved forage production (unable to quantify)

In addition, there may have been some reduction in dissolved solids in

Sheep Creek in concert with the sediment reductions. However, we have no data to support this.

Project Design Considerations

We agree generally with the methodsused to accomplish the original objectives in Sheep Creek. Gully plugs and detention dams were proper- ly located and designed. There are additional opportunities and suitable sites for the type of gully plug treatment used on the National Park lands. This type of treatment could have been expanded to other appropri- ate areas of the watershed. The water-spreader systems, although effective in trapping water and sedi- ment, could have been designed to more effectively release water and irrigate the target areas below the systems. We did not formally evaluate the plowing, chaining, and reseeding treatments.

Generally, we believe mechanical or structural watershed treatments should only be applied in situations where watershed condition is so severely degraded by past management practices that natural recovery will be inefficient. The treatments should permit a watershed to reach a condition of natural stability and function more rapidly than can be achieved without treatments, and the multiple resource benefits achieved by watershed treatments should justify the costs. Finally, when possible, the achieved watershed condition should be sustainable with proper land use management, and should not be dependent upon continued structure integrity and maintenance. Where continued structure functioning will be required, the structure should be built with an extremely long design life and incorporate features that will require a minimum amount of future maintenance.

Acknowledgments

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.

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Land reclamation in Iceland.
Runolfsson, S.
Soil Conservation Service of Iceland, Gunnarsholt, 850-Hella, Iceland.
Arctic and Alpine Research, 1987. 19 (4): 514-517 (17 ref., 2 fig.)
Language: English
Document Type: NP .(Numbered Part)
Status: NEW
Subfile: OS .(Soils and Fertilizers)
Erosion is one of the most severe ecological problems in Iceland. It has been estimated that more than 50% of the original vegetative cover has been lost since settlement in 874 and active erosion continues to be widespread throughout the country. Since its founding in 1907, the Soil Conservation Service of Iceland (SCS) has emphasized control of wind erosion and reclamation of eroded areas. Methods have primarily involved stabilizing sand dunes with Elymus arenarius and reseeding eroded lands with grasses such as Festuca rubra and Poa pratensis. Approximately 2% of Iceland has been fenced off by the SCS to exclude livestock grazing from areas experiencing severe erosion. The vegetation has recovered considerably within these protected areas and in other areas where grazing intensity has been reduced. The rate of recovery varies greatly depending on elevation, soil type, proximity to natural seed sources, and reclamation practices.

Descriptors: reclamation; eroded soils; iceland; soil types (anthropogenic)
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Geographic Names: Iceland
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Section Headings: 2 FERTILIZERS. SOIL AND CROP MANAGEMENT - 26 RECLAMATION. SOIL CONSERVATION. WATER CONSERVATION .(SC=OS260000)

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Erosion control-you're gambling without it. Proceedings of Conference XVIII International Erosion Control Association.
Hooper, R.; Haveran, B. P. Van; Jackson, W. L.
Bureau of Land Management, P.O. Box 724, Cedar City, UT 84720, USA.
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OK

Descriptors: erosion control; usa; utah; conferences
Decimal Codes: OS185; OS260; (7)
Geographic Names: USA; Utah
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Environmental influences on the distribution of savanna vegetation.
The savannas, biogeography and geobotany.
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A brief review of environmental influences on the distribution of savanna vegetation is given. The physical environment of the savanna lands is describad including climate, soils, geomorphology, geology, and soil development. The influence of physical factors on the distribution of savanna vegetation is considered. The influence of biotic factors on the distribution of savannas is discussed with reference to: the evolution of wild herbivores; the distribution of wild herbivores; the introduction of domestic herbivores; tha conservation of wildlife; and the intarrelationships between vegetation and fauna. Tha roles of fire and of man's cultural practices are examined.

Descriptors: grasslands; savannas; burning; grazing
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